January 4, 1960

SUMMARY REPORT ON UTILIZATION RESEARCH
Fiscal Year 1959
Agricultural Research Service
U. S. Department of Agriculture

prepared for

Committee on Appropriations
U. S. Senate
86th Congress
2nd Session

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Summary Report on Utilization Research in the Agricultural Research Service, U. S. Department of Agriculture, Fiscal Year 1959

I. INTRODUCTION

This report is submitted in response to the request made by the Committee on Appropriations in its report to the Senate on the Agricultural and Farm Credit Administration Appropriation Bill, 1960, (Report No. 330). This request, on page 4, paragraph 3 of the report under the section entitled, "Utilization Research", reads as follows:

> "Further, the committee specifically requests that it be kept advised by an annual summary report on research developments, including the work in progress at these laboratories, proposed new work, and on projects to be discontinued due to completion of work or lack of results with the reasons for discontinuance. It is the hope of the committee that it will be kept better advised not only as to specific accomplishments in the field of utilization research but also as to fiscal requirements at these installations."

The objective of the utilization research program of the Agricultural Research Service is to enhance the use-value and competitive position of farm products in such a manner as to provide more income for the farmer from the crops that he grows. Emphasis is on the development of industrial uses for those crops in surplus. Successful utilization research not only benefits farmers, but also aids American industry and provides consumers with new and improved products that better satisfy their needs.

In planning its utilization research program, the Agricultural Research Service has the benefit of the advice and cooperation of many organizations and individuals both within and outside the Department of Agriculture. Among these are the farm research, marketing research, and home economics research divisions of the Department, the Department's Commodity Advisory Committees, the defense agencies, the State Agricultural Experiment Stations, farm and industry associations, consultants and collaborators, and representatives of industrial and private research organizations. All segments of the utilization research program are systematically reviewed and appraised for the purpose of reorienting current lines of work in the light of recent developments in agriculture and in industry to assure maximum benefits in the shortest time practicable.

Utilization research highlights of fiscal year 1959, including commercial applications, are summarized as follows:

> Dialdehyde starch, a new industrial starch product is now in semi-commercial production by two companies. This new starch derivative is being evaluated for tanning leather, improving the wet strength of paper, making adhesives and for other industrial uses.
>
> Cooperative efforts by utilization research chemists, corn breeders and industry resulted in two companies producing 250,000 pounds of high-amylose corn starch from the 1958 crop of a new hybrid high-amylose corn. This new starch is being evaluated for application as paper additives, textile sizes, adhesives and packaging films.

Vinyl stearate, a new type of plastic chemical made from animal fats, is undergoing successful commercial development.

Production of dehydrated potatoes in both flake and granule forms continues to expand -- 150 million pounds (estimated) in 1959 from 20 million bushels of potatoes.

A new type machine for carding cotton, the first major improvement of the carding machine in 200 years, saves much of the fibers normally discarded as waste. Released to the textile industry March 1959, 18 of these granular cards were installed in textile mills during the first 6 months and licenses indicate that as many as 75 will be installed by the end of 1959.

A practical method for stabilizing important oil-soluble nutrients (beta-carotene, xanthophylls, vitamin E) of dehydrated alfalfa and other forages was completed and 46 companies were licensed to use the process.

A wool processing research laboratory was dedicated and placed in active service at the Western Utilization Research and Development Division, Albany, California. It is an integrated pilot plant consisting of the most advanced wool processing equipment and provides versatile means for processing research and practical evaluation of new laboratory developments in the improvement of wool textiles.

A simple and effective heat-phosphate treatment of milk was developed for preventing growth of bacteriophage (a virus disease of bacteria) in bacterial starters used in making cheese and fermented milks, thus affording industry with a practical means of preventing serious economic loss.

A new Fruit and Vegetable Laboratory was completed at Winter Haven, Florida to better serve the fruit and vegetable growers and processing industries, particularly those in the south, in the development of new and extended uses for those crops.

Water-soluble zein, a protein of corn, was developed and taken over by industry for use in protective coatings, finishes and other products.

Defense agencies adopted the Department's improved flame retardant finish for cotton. Known as APO-THPC, treated fabrics are durable to laundering and dry cleaning, and are also resistant to shrinkage, mildew, rot and wrinkling.

A Product and Process Evaluation Staff was established in the Administrator's office to assist in guiding research along most productive lines by determining properties and cost requirements for new products and estimating size of potential markets.

Two million pounds of new chemicals from turpentine, principally pinane hydroperoxide, are now being used as catalysts in the production of synthetic rubber. It is estimated that 90 percent of current annual production of one-half million tons of GRS "cold rubber" tread stock is made with these turpentine chemicals as ingredients.

Wash-wear and flame resistance have been imparted simultaneously to cotton cloth by a new chemical known as APO. Several companies are working to devise methods for production of the chemical to allow for its economic use as a cotton finishing agent.

The chemical screening of the seeds of more than a thousand new plants has resulted in the discovery of seeds containing oils of unusual composition. Four classes of these new oils have properties different from those now produced domestically and offer sufficient promise for industrial applications to warrant undertaking developmental studies.

Utilization research scientists of the Agricultural Research Service were recognized for outstanding contributions by industrial and other organizations in fiscal year 1959 with the following awards:

National Association of Frozen Food Processors Award of Merit

"In recognition of outstanding contributions in fundamental and applied research in frozen food technology by the Western Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture, which has so greatly aided in the development of the frozen food industry, this Award of Merit is gratefully presented on the second day of March, 1959, at the 18th Annual Convention of the Association."

Glycerine Products Association top 1958 award for outstanding research accomplishment in the application of glycerine or glycerine derivatives to Leo A. Goldblatt and Robert S. McKinney for their joint work on the synthesis and examination of the unique properties of tung oil monoglycerides. The award consisted of a plaque and $1,000.

National Frozen Food Distributors Association Plaque

"This award is presented as a mark of the appreciation and admiration of the entire frozen food industry for the work of the research team of scientists in the Albany and Pasadena, California laboratories of the United States Department of Agriculture, who conceived and carried out the authoritative and comprehensive investigations of the time-temperature tolerance of frozen foods."

Institute of Food Technologists Industrial Achievement Award to the Eastern Utilization Research and Development Division for the development of potato flakes. This was the first presentation of this award, which is made "to honor an outstanding food process and/or product which represents a significant advance in the application of Food Technology to food production."

The Charles G. Woodbury Award in Raw Products Research, was given by the American Society for Horticultural Science, to A. H. Carter, D. W. Ingalsbe and A. M. Neubert (with E. L. Proebsting of Washington State University) for the best research paper on improvement of raw products for canning presented at the 1957 meeting of the Society. Their paper was entitled, "Relation between Leaf Nitrogen and Canning Quality of Elberta Peaches".

1959 Herty Medal was presented to Dr. C. H. Fisher, Director, Southern Utilization Research and Development Division, by the Southern Section of the American Chemical Society on May 2, 1959, at Milledgeville, Georgia. This Medal is awarded annually for outstanding contributions to the field of chemistry in the South.

American Oil Chemists Society - Bond Award, to Joseph Coleman and Daniel Swern for the best paper presented at the 1958 fall meeting of the American Oil Chemists Society.

Borden Award for Outstanding Research in Milk Chemistry to Dr. C. A. Zittle for his studies on the effect of heat on the stability of milk under various conditions. The award consists of a gold medal and $1,000.

National Science Foundation Award of a one year's scholarship at the University of Strassburg, France, to S. N. Timasheff for an "Outstanding Research Record." Dr. Timasheff is conducting fundamental research on animal proteins.

National Science Foundation Award of a Senior Postdoctorate Fellowship to Dr. Sigmund Schwimmer for outstanding accomplishments in the field of enzymology. Dr. Schwimmer carried on research at the Royal Agricultural and Veterinarian College, Copenhagen, Denmark.

The results of utilization research are made available in many different ways. During the fiscal year 1959:

493 research papers were published

527 papers and talks were presented at meetings

96 patents were granted; 79 licenses were issued

88 industry conferences were held at the laboratories to aid in the commercialization of research developments

40 showings of exhibits illustrating research accomplishments were made at national and regional meetings

145 press releases on research were issued

78 appearances were made on radio and television programs

5,000 technically trained visitors, representing public and private research laboratories and industrial concerns, came to obtain information on specific research developments.

A comprehensive bulletin NEW USES FOR FARM PRODUCTS was issued describing the utilization research program and recent accomplishments, and a fifteen minute film with the same title was released.

II. RESEARCH ACCOMPLISHMENTS

Some of the more important research developments during fiscal year 1959 were as follows:

Wash-Wear Cotton Finishes

Some 800,000 bales of cotton were used last year that would not have been used but for the development of the new wash-wear, wrinkle-resistant finishes. Fundamental research by the Department has provided valuable information for the development of new and improved wash-wear finishes. Several different chemicals are being used commercially to impart wrinkle resistance to cotton fabrics, but none of them gives a completely satisfactory product. A new wash-wear treatment, using a chemical known as APO, has been developed by Department scientists that has good commercial potential. It imparts an outstanding degree of wrinkle resistance, has little effect on the hand and drape of the fabric, and is more durable in both home and commercial laundering than currently used treatments. Present cost of APO is high, but encouraged by the potential of this development, several companies are working to devise low-cost production methods.

Water-Soluble Zein from Corn in Commercial Production

Zein, a protein component of corn, has been chemically modified to produce a water-soluble product having a variety of industrial uses. The major manufacturer of zein has adopted this process and has reported wide commercial acceptance of the product. Water-soluble zein produces hard, tough, grease,-resistant films that are desired in a variety of applications. Industrial uses are in rubless floor polishes, adhesives, printing inks, leather finishes, films and protective coatings, pharmaceuticals, and cosmetics. The new product offers promise of greatly expanding outlets for this corn protein, and is another step toward the goal of finding increased industrial uses for all the major constituents of corn.

New and Improved Dehydrated Mashed Potatoes

New and improved processes for dehydrated mashed potatoes have been developed. The improved quality and convenience-in-use of these dehydrated products are expected to substantially increase potato utilization, which at present exceeds 20 million bushels annually for this use. Potato flakes, a new form of dehydrated mashed potatoes developed by the Department, has now achieved important commercial status, with the building of two new potato flake plants during the past year to bring the total to ten plants. For the potato flake development, the utilization research group received the 1959 Institute of Food Technologists first industrial achievement award for "Outstanding Advances in the Application of Food Technology to Food Production." Also, a new process for making potato granules, another form of dehydrated mashed potatoes, has been developed which is simpler and easier to control than the one now used commercially. The new process is continuous and involves no recycling as is the current practice; commercial-scale evaluation is pending.

Stabilization of Dehydrated Alfalfa Commercialized

A practical method of stabilizing some of the more valuable nutrient constituents of alfalfa and other forages has been developed. The principal value of dehydrated forages as ingredients of mixed feeds is dependent on their content of provitamin A (B-carotene), Vitamin E, and Xanthophyll. Unfortunately, when the forage is stored for winter use these valuable components are rapidly destroyed by natural oxidation. Of several hundred chemicals screened as stabilizing agents for these components, 6-ethoxy-2,2,4-trimethyl-1, 2-dihydroquinoline was found to be most suitable. Applied at a rate of about one-half pound per ton and at a cost of not over $1.00, about three-fourths of the labile nutrients are retained over a storage period of 6 months as compared to a one-fourth retention for untreated forage stored under the same conditions. Forty-six alfalfa dehydrating companies, representing a large proportion of dehydrated alfalfa production capacity, have been granted licenses to use this development under the Department's public service patent.

Dialdehyde Starch in Semi-Commercial Production

Two industrial companies are now producing semi-commercial quantities of dialdehyde corn starch and are planning expansion. Both companies are using the Department's improved two-stage electrolytic process. Utilization research has demonstrated usefulness of dialdehyde starch in leather tanning and as an agent for producing wet-strength paper. Other promising outlets to be developed include adhesives and binders, oil-well drilling additives, gelatin conditioners and film-hardeners, textile processing aids, and as a chemical intermediate. The unusually high response to advertisements and announcements by the manufacturers of the availability of the commercial products indicates extensive research by industry for applications of this new material.

Chemical Treatment Imparts Permanent Creases to Wool Garments

A new process using a chemical known as dimethysulfoxide has been developed that imparts permanent pleats and creases to wool fabrics. This essential step in making truly wash-wear wool garments will place wool in an increasingly favorable competitive position with the man-made fibers. The desirable qualities of hand, drape and moisture absorbency are not lost by the treatment. Pleats and creases durable through numerous washings in ordinary home-style washing machines are obtained. The treatment is equally effective with wool fabrics that have been made shrink-proof with another treatment previously developed using epoxy resins. This process is an outgrowth of basic research on the effect of chemicals on wool proteins.

New Type Corn Starch for Industrial Uses Made Available in Semi-Commercial Quantities

Cooperative efforts by chemists, corn breeders, and industry have resulted in two companies producing 250,000 pounds of high-amylose corn starch from the 1958 crop of a new hybrid -- high amylose corn. This new starch contains 55-60 percent amylose, the component of starch with properties

that make it attractive for expanded industrial uses. It is undergoing extensive evaluation for industrial application as paper additives, textile sizes, adhesives, and packaging films. The importance of these investigations is further emphasized by the recent development of an 80 percent amylose corn and the promise that still higher amylose-containing corns may eventually become commercially available.

Development of Industrial Products from Wheat Flour

An economical process has been developed for reacting wheat flour with a variety of chemicals to produce modified flours that have properties and viscosity behaviours needed for applications as adhesives and as sizing and coating materials for paper and textile products. Evaluation studies for a number of industrial end uses are now in progress. Wheat flour is available in large quantities at 5 to 6 cents per pound and its modification for industrial use offers a most promising route for expanded outlets. Low-protein flour fractions are now becoming available through new milling processes. Limited studies with these products show that they are also amenable to chemical modification for industrial use.

Breakthrough in Chemistry of Wheat Gluten Provides Sound Basis for Further Advances in Utilization

An understanding of the chemistry of wheat gluten is essential to the development of industrial applications and exploiting more efficiently its properties for food uses. In the past, wheat gluten was considered to contain only two separable components--gliadin and glutenin. A major advance in gluten chemistry achieved in Department research, is the development of techniques that have resulted in the separation of gluten into six protein components and the demonstration that gliadin and glutenin are mixtures. Four of these components have been prepared in quantities for detailed laboratory study. Research on these protein components is being pursued to take advantage of the complexity that nature has built into them in order to adapt them to industrial applications.

Fermentative Conversion of Corn Sugar to Industrial Gum-like Products

Methods have been devised for transforming corn sugar, through fermentative procedures, into new gum-like polymers having properties which open new applications for corn products. One of the several polymers produced from this study is a gum, called phosphomannan, which is readily soluble in water to give clear viscous solutions. Extensive evaluation by over 30 companies, four of which are studying it from the production viewpoint, reveal uses in foods, pharmaceuticals, cosmetics, paper, and other applications as a thickening, stabilizing, dispersing, and suspending agent.

New Plant Hormone from Corn Sugar in Commercial Production

The process developed for producing gibberellin by fermenting corn sugar with certain molds has been commercialized by seven manufacturers. A source book containing all published references on gibberellin has been

published and has received wide recognition by researchers and industry. Agricultural applications of this remarkable new plant hormone are for stimulating growth of forest and shade trees, increasing height and substance of above-ground parts of agronomic and vegetable crop plants, hastening germination of seeds and flowering of plants, and inducing fruit set. The many trials of the effects of gibberellin on farm crops now in progress are expected to reveal other important uses.

Information on Industrial Fermentation Made Available

Basic and applied research on applications of fermentative type reactions to the development of industrial products, based on agricultural commodities, has been hampered by inadequate information on the available literature. An important contribution to this field was an exhaustive literature survey, published in book form, on the chemical reactions induced by microorganisms. This publication has received enthusiastic endorsement from scientists working in the industrial fermentation field and from colleges where courses are conducted on industrial fermentations. It is stimulating interest in producing industrial products through fermentation of agricultural products.

Frozen Products Making Substantial Gains in Baking Industry

Department research has provided basic information on the effect of temperature, air velocity, relative humidity on freezing and thawing rates, and on the stability of frozen bakery products during and subsequent to processing. It has been found that bread and other bakery items each must be handled according to individual requirements. Freezing leads to greater plant efficiency and economy of production by eliminating peak loads and minimizing change-over times of production lines for manufacturing different items in the same equipment. Another real advantage is that better products are available to the housewife. The fresher, tastier, baked goods for consumers resulting from this new processing procedure, should increase the consumption of wheat. Over 60% of the Nation's bakeries have installed some kind of freezing facilities.

The Secrets of Fresh Bread Flavor Unfold

Development of methods for preserving the delightful flavor and aroma of freshly baked bread and other baked goods is necessary if wheat is to maintain and expand its use as a food crop. To produce and retain these desirable but unstable properties to a maximum degree, more specific information on the chemical constituents involved is needed. This need is becoming more and more critical because new methods being adopted by the baking industry to speed up production and reduce costs are resulting in products with suboptimum flavors. Substantial progress has been made in determining the nature of the constituents responsible for the enticing fresh bread flavor. The research has definitely established that several broad classes of chemical compounds are involved in flavor and aroma formation. Among those identified are alcohols, acids, esters, and carbonyl compounds. Complete knowledge of flavor constituents and factors affecting their individual stabilities are necessary in determining procedures that must be used to stabilize these critical and sensitive compounds.

Estrogenic Hormone Identified in Forages

Cooperative studies of Department and State Experiment Station scientists have resulted in the isolation of a new estrogen (female sex hormone) from ladino clover. Subsequent investigations have shown this substance, named "coumestrol", to occur in varying amounts in all principal legume forages grown in the U. S. The coumestrol content of processed forages varies for reasons as yet unknown. Continued research on forage composition in relation to coumestrol and other estrogenic constituents, and the effect of processing operations on these materials should lead to higher, more uniform quality processed forages with greater economic returns to the industry.

Improved Rice Drying Methods

Studies in rice processing plants over the past two seasons have shown that the benefits obtained on western short-grain rice by improved drying procedures can also be obtained on southern medium-grain rice. The plants at which the studies were conducted have adopted the new procedures. In one of the cooperating plants, operating conditions were established by which plant drying capacity was increased 50% without loss of rice quality and with substantial reductions in operating costs. Increased drying capacity is also of great economic importance to the growers because it permits more rice to be dried at optimum maturity and thus avoids cracking of kernels caused by exposure to severe field drying conditions after maturity. Conservative estimates, based on known losses resulting from failure to harvest at optimum maturity, indicate that income of rice growers and millers might be increased several million dollars by general adoption of the improved drying methods.

New Method of Carding Cotton Shows Great Promise

The textile industry has enthusiastically responded to the announcement of a major modification made in the cotton carding machine to improve its operation. This modification, which is the only major change made in the carding machine since its invention 200 years ago, effects a significant reduction in manufacturing costs. This is accomplished by replacing heavy, cumbersome wire combs with a lighter weight, granulated metal surface, Commercial mill tests show a saving of much of the spinnable cotton fibers normally removed as waste by the conventional carding machine. Released to the industry in March 1959, 18 granular cards have already been installed in textile mills and licenses indicate that as many as 75 will be installed by the end of this year.

Improved Flame Retardant Finish for Cotton Meets Requirements of Army Quartermaster Corps

A new flame retardant, APO-THPC, developed in cooperation with the Quartermaster Corps, is superior to other flame retardants for cotton. Fabrics treated with APO-THPC are not only resistant to burning, but also resist shrinkage, mildew, rot and wrinkling. The treated fabric retains these

properties after repeated laundering and dry cleaning. The Army Quartermaster Corps consider that the APO-THPC flame retardant finish meets its current requirments for a satisfactory flame retardant on cotton fabric for certain military uses. A textile mill, which has made successful pilot plant applications of APO-THPC to various fabrics, plans to evaluate this new finish on work clothing fabrics for civilian use.

New Chemical Treatment Increases Durability of Cotton Fabrics Used in Outdoor Service

Research conducted jointly with the Canvas Products Association International has shown that the resistance of cotton canvas to mildew and discoloration by algae can be greatly increased by the use of a commercially available chemical, cadmium selenide, which confers greater resistance to this type of deterioration than standard commercial treatments. Fabrics given this treatment have remained completely free of mildew and algae after two years of continuous, outdoor exposure. The cadimum selenide, applied with a resin binder, is especially applicable to awning fabrics. Experimental awnings are now being evaluated by the U. S. Coast Guard and by a firm that processes fabric for awning manufacturers.

Research Points Way to Minimizing Damage to Cotton During Ginning

Overdrying seed cotton during cleaning and ginning causes excessive fiber breakage and results in lowering yarn quality and increasing manufacturing costs. The rapid expansion of mechanical harvesting and the widespread adoption by gins of auxiliary cleaning and drying equipment have brought with them certain practices that substantially lower the spinning or use value of cotton in a manner that is not reflected by the official U. S. Standards for grade and staple. Due to the very large number of variables that affect the quality of cotton during ginning, it has been extremely difficult to pinpoint the nature and cause of this damage. Department utilization, production, and marketing research personnel, working cooperatively with industry have identified overdrying as a major cause of damage at the gin. This information is now being used in efforts to eliminate ginning practices known to damage the cotton excessively.

Improved Potato Chips

A method of preventing blisters from forming on potato chips has been developed as an outgrowth of research. Blisters are often filled with oil; when they break, the oil is spilled over other chips, making them greasy. Chip manufacturers sort out as many blistered chips as possible — a costly hand operation — but enough slip by to hurt sales. The new process involves heating the raw potato slices in water containing a small proportion of calcium chloride, which bonds the individual tissue cells together. The cells are held together so that blisters do not form under the stress of frying. The finished chips are not only free of blisters, but have a more uniform and attractive color than those produced without this treatment. The interest of numerous manufacturers indicates that the process will be valuable to the potato chip industry, which now has sales of about $500,000,000 per year.

Origin of Lemon Oil Off-Flavor Discovered

For years food and flavor manufacturers in the U. S. and Europe have been troubled by the development of off-flavors in lemon oil. Repeated efforts to stabilize this important food flavoring constituent have been unsuccessful. Basic research on the composition of the oil has confirmed that para-cymene is the chemical compound responsible for the off-flavor, but of greater importance, this research has shown that gamma-terpinene is the constituent from which this para-cymene is evolved. Previously, it was considered that para-cymene resulted from breakdown of citral, the main aroma component of lemon oil. This new finding explains the failure of previous attempts to stabilize lemon oil and suggests new approaches to the problem.

Potentially Important Fatty Acid Produced in High Purity by a Commercially Practical Process

A high purity linoleic acid has several uses that might result in a large industrial volume if it could be produced economically. In resins for paints, linoleic acid imparts hardness without appreciable yellowing of the films. In the production of chemical intermediates for use in other products, a high purity linoleic acid gives superior end products. A process was developed for producing this high purity linoleic acid from safflower oil. Cost studies indicate it should be commercially feasible. A number of industrial companies are evaluating the product.

Improved Soybean Oil Through Radioactive Tracer Techniques

Flavor instability of soybean oil is the most important problem of this industry and a principal cause of this property is attributed to the presence of a small percentage of linolenic acid, an unstable compound. The selective hydrogenation of the linolenic acid component of soybean oil to a more stable form should go far in solving this problem but to date this has not been possible. One of the difficulties of past work has been inadequate analytical methods for hydrogenated soybean oil to determine if the desired product had been obtained. Basic work on the use of radioactive hydrogen to selectively hydrogenate the soybean oil has revealed a new research approach to the study of this problem. This technique should permit rapid evaluation of a number of hydrogenation procedures to determine point of entrance of the hydrogen and extent of hydrogenation required to provide a flavor-stable soybean oil.

Plastic Foams Made from Modified Castor Oil

An economical chemical process for altering the properties of castor oil has been developed that extends the potential usefulness of castor oil in the manufacture of types of lightweight plastics known as urethane foams. Foamed plastics made with this chemically modified castor oil possess distinctly improved water resistance and shrinkage resistance, characteristics that have been serious limitations of urethane foams

generally. In spite of these shortcomings, urethane foams are being used in increasing quantities for upholstering materials, thermal and accoustical insulation, foamed-in-place crash pads, lightweight structural materials, and numerous specialty products. Approximately a million pounds of unmodified castor oil were used in 1958 to produce urethane foams. Development of this economical process for producing foams with significantly improved properties provides a potentially greater use for castor oil in this rapidly expanding industry.

Increased Export of Soybeans for Japanese Foods May Result from Cooperative Research

Japan is the largest single foreign consumer of United States soybeans, representing about 25 percent of our export of these beans. The Japanese who use the whole bean in preparing their traditional foods, object to certain characteristics of U. S. soybeans such as uneven cooking, darker colored products, and different flavor. Two Japanese scientists worked for approximately a year in one of the Department's utilization laboratories on evaluating typical U. S. soybeans in selected Japanese foods and plan to continue their work in Japan. This was a cooperative project between the Agricultural Research Service, Foreign Agricultural Service, and the American Soybean Association. New approaches to the preparation of these foods from U. S. beans were developed. This work should ultimately improve the acceptance of U. S. soybeans in Japan.

Emulsion from Cottonseed Oil Supplies Long-Felt Need for Better Intravenous Feeding

A fat emulsion made from cottonseed oil for intravenous feeding may provide better nourishment for patients who cannot be fed by mouth than the commonly used glucose solution. Development of such an emulsion has been done in cooperation with the U. S. Army Surgeon General's Task Force on Intravenous Fat Emulsions. The new emulsion has given good results in trials on animals conducted at the Louisiana State University School of Medicine. Long-term intravenous administration of the emulsions at high levels have given very encouraging results when administered to dogs. The animals tolerate more of this emulsion than any other fat emulsion tested. It is believed ready for clinical tests on human subjects. The ideal fat emulsion for intravenous feeding would be one which could be used for an unlimited number of infusions without any injurious effects.

New Use for Cottonseed Soapstock

Industry has adopted a practical process for esterifying cottonseed refinery soapstock on "foots" to produce a product for use in feeds. Corn oil-, peanut oil- and soybean-oil foots can also be used as raw materials. The new product provides a new market for the low-cost vegetable oil soapstock previously used in the production of soap and fatty acids and is finding ready markets as a high energy additive in livestock feed, and in feeds for broilers, laying hens, and turkeys. At the present time, one commercial firm is manufacturing 15 million pounds of product per year. This company is also working on the production of a more purified product for use in plastics and other industrial products.

New Vegetable Oils of Industrial Interest Discovered in New Crops Program

The chemical screening of new plants has resulted in the discovery of seeds containing oils of unusual composition. Of a total of 1,037 seed samples analyzed, representing 655 plant species, 151 contain unusual types of oil. Four classes of these new oils with properties different from those now produced domestically offer promise for industrial applications not competitive with present domestic oils. These four classes of oils are undergoing preliminary developmental studies. Seeds from which these oils were obtained are produced by hardy plants that have good potential for development into commercial domestic crops.

New Chemical from Turpentine used in the Production of Synthetic Rubber

Research conducted in cooperation with the Office of Rubber Reserve has shown how turpentine can be transformed into excellent catalysts or initiators (peroxides) for the manufacture of "cold rubber". For example, the initiator called pinane hydroperoxide is produced from turpentine by a simple two-step process developed by the Department. About 2,000,000 pounds of peroxides are currently used per year in the production of synthetic rubber. It is estimated that 90% of the current annual production of 500,000 to 600,000 tons of GRS tread stock "cold" rubber is made with the turpentine peroxide initiators developed by the Department.

Relationship Between Tobacco Quality and Composition

Knowledge of the relationship between chemical composition and quality of tobacco is of great importance to the future of this industry. Utilization research seeks, in cooperation with the industry, to isolate and identify the various constituents in tobacco and in tobacco smoke, and to make this composition data available to the industry and the public. During the past year a phase of this research problem relating to the sterol and paraffin components of tobacco was completed. Three new sterols were isolated and identified, making a total of five found in this study. Since knowledge of tobacco paraffins is of value in smoke studies related to tobacco quality, a specific analytical method for these substances was developed.

Improved Maple Sirup

While maple flavor gives the desired and distinctive property to maple sirup, the color of the sirup is even more important economically for it is the price determining factor. Department research has shown that the color of maple results from microbial fermentation products which interact during the evaporation of the sap. Based upon this finding, the Department has developed improved sap handling and evaporation methods which have so reduced sap fermentation that 80% of the 1959 maple sirup crop was of the two top (light colored) grades, whereas previously not more than 50% of the crop was top quality. This improvement has increased farm incomes from maple sirup by approximately $300,000 annually.

New Uses for Animal Fats in Plastics

Vinyl stearate, a chemical prepared from a major component of animal fats, is now in commercial production and use as a result of research by the Department and through cooperation with potential industrial manufacturers and consumers. Broad uses for vinyl stearate are being developed--some are already commercialized--in water-base paints, lubricating oil additives, fibers, permanently flexible plastics, waxes (especially aerosol spray-type), textile and paper coatings, and adhesives. Also, as a result of research efforts, epoxidized fats and oils are finding a growing outlet as stabilizers for vinyl type plastics. Several methods for incorporating epoxidized fats in basic plastic compositions are now available to make possible the use of epoxidized fats in protective coating resins such as the "alkyds". Commercial development in this application has already begun; eventual use of as much as 200 million pounds of epoxidized fats annually for this outlet is forecast by some industrial authorities.

New Class of Plasticizers from Animal Fats

A new class of phosphorus-containing plasticizers (plastics softening agents) which impart lasting low temperature flexibility to polyvinyl chloride type of plastics has been developed that utilizes inedible animal fat derivatives. Added to the plastic base to the extent of about 35%, they keep the material soft and flexible even when exposed to below zero temperatures (-30° to -50°F), yet they escape from the plastic at a much slower rate than any other known low-temperature plasticizer. Thus the flexibility-life of the plastic end-product is increased. Potential uses for the improved plastics include wire coatings, auto seat covers, galoshes and other protective clothing--articles exposed to a wide range of temperatures. These new plasticizers may also have an important application in functional all-temperature fluids, such as lubricants and hydraulic fluids. Industrial interest in these new animal fat products is high.

Progress in Development of Foam-Dried Whole Milk

Fundamental and developmental research on foam-dried milk has progressed to the stage that a pilot scale plant has been installed to further this development. Significant progress in adaptation of the process to continuous operation has been made. Research directed to improvement in flavor stability has revealed the presence in butterfat of a substance which yields tallowy flavored "carbonyls". This striking discovery may well contribute to solution of the serious problem of stale flavor development of dried whole milk in storage. Work is progressing to develop means for controlling oxidative off-flavors, for increasing plant capacity, and for increasing product density to improve packaging and handling characteristics.

Factors Affecting the Physical Stability of Evaporated Milk Clarified

Basic information about the causes of clotting or gelling of concentrated milks during storage has been obtained by a study of the binding of certain milk salts (calcium and phosphate) with milk proteins. This information is important to the milk industry since spontaneous gelling of milk concentrates stands in the way of quality improvements to minimize cooked flavor, and thus affects broadening of market outlets. The degree of acidity was found to be the most important variable for binding of these milk salts to the proteins. Calcium proteinates thus formed have properties which account for their lack of stability during heating. This investigation merited the Borden Award for 1959, from the American Chemical Society, for research on the chemistry of milk.

New Method for Growing Bacteriophage-Free Cheese Starters

Starter cultures used to convert milk into cheese often become contaminated with bacteriophage, a virus that destroys the starter bacteria, and results in serious economic loss throughout the cheese industry. A simple and effective heat-phosphate treatment of milk for preventing growth of bacteriophage in cheese starters has been developed. This outstanding discovery is already in wide commercial use in the cheese industry. Conservative estimates indicate a potential saving of several million dollars annually to the industry.

Improved Uses for Leather

Two new tanning processes give good indication of opening new uses for leather and of reducing costs of leather production, thus broadening the markets for these animal products. A process for pretanning of heavy cattle hides with dialdehyde starch (a product under development in another part of the Department's utilization program) holds promise for shortening the traditional two- to three-months' tanning process for sole leather. This rapid and potentially economic process, which can be done in existing tanning equipment, would help to counteract the serious dislocations in the utilization of hides created by the increased competition from leather substitutes, would create a domestic source of tanning materials, and would assure wider industrial uses of starch from cereal grains. Evaluation of the economics of the process is now being done in a commercial tannery. In another new tanning process, based on glutaraldehyde, garment leathers are produced that dye easily and are resistant to perspiration and to laundering. Two companies have adopted this process. The process is very versatile, permitting its use over a wide range of conditions. An outstanding advantage of this process is that the tannage can be completed in only four hours. It is compatible with conventional tanning materials such as vegetable, chrome, alum and zirconium, for the production of wide variations in leather properties.

Basic Research on Hide Substance Elucidates Tanning Mechanism

Research on the physical properties of hide and leather substances has provided new and valuable basic information on the function of a tanning agent. The results demonstrated for the first time that the shrinkage of hide at elevated temperatures is a result of melting of the more ordered regions comprising the internal structure of hide substance. The temperature at which shrinkage takes place was demonstrated to depend on the amount of water that could reach the internal structure. Thus one important function of a tanning agent in producing leather is simply to prevent water from reaching the internal structure of hide. These findings will be valuable guides in developing improved tanning processes and new uses for leather. The importance of this basic research was recognized by the American Leather Chemists Association which awarded a $1,000 prize to the authors of a paper describing this work. This research work also was presented, by special invitation, before the International Union of Leather Chemists Societies, Munich, Germany in September 1959.

Improved Egg Solids

Whole egg powders of near-instant dispersibility have been prepared by a new process in which mechanically-formed foams are dried in heated air. Flavor stability combined with good performance value has been achieved by carefully selecting the type and level of carbohydrate added to the egg products before drying. Industry evaluation is now in progress. This discovery opens the door to additional usage of whole egg and yolk solids in such convenience food items as omelet, custard, pie filling and egg drink mixes. Heretofore, yolk-containing egg solids have been limited in their usefulness by certain quality deficiencies such as poor dispersibility, flavor instability in air, and substandard foaming and emulsifying power. Products made by this new process do not have these undesirable properties.

New Developments Promise Extended Egg Usage

Surplus egg white continues to represent an imbalance in the egg products industry. Development of methods for producing a product free of pathogenic Salmonella microorganism should lead to increased utilization of albumen, a major constituent of eggs. Promising results have been obtained by two different approaches: (1) Ultraviolet light treatment of egg white in thin centrifugally formed films; (2) in the predrying desugaring step, selective fermentation with harmless microorganisms that are antagonistic to Salmonella and therefore limit Salmonella development. Application of one or both of these findings, should lead to new and broader uses, in both domestic and export markets, that depend on the availability of Salmonella-free or pasteurized products.

III. PROGRAM MODIFICATIONS TO MEET CHANGING NEEDS

The utilization research program is continuously reviewed and modified to keep it on important problems, to keep it productive, and to make it responsive to the changing needs and demands of industry and consumers. Productive leads are pursued to the fullest extent resources permit. Shifts in program are made to projects of higher priority where opportunities become apparent. Unpromising lines of work are discontinued. Examples of such program shifts in utilization for fiscal year 1959 were:

Investigations on agricultural residues were terminated in order to intensify research on industrial utilization of corn and wheat.

Research to determine the chemical suitability of certain plant components for the manufacture of cortisone was completed, and personnel reassigned to work on the development of new industrial products from surplus animal fats.

Cooperative work has been initiated with the Atomic Energy Commission and the Department of Health, Education and Welfare to develop a standby commercial method for removal of radioactive strontium-90 from milk.

Research on the synthesis of new types of plant growth regulator compounds from agricultural chemicals was completed, and the personnel reassigned to development of new chemical uses for surplus animal fats and to basic research on animal fat chemistry.

An intensive research program has been initiated, in cooperation with the National Flaxseed Processors Association, to develop a linseed oil emulsion paint suitable for outside use, a use seriously threatened by inroads of synthetics.

Selected phases of the new crops screening program were curtailed to permit developmental studies on new types of vegetable oils having good potential for industrial applications that are non-competitive with domestic oils.

Research on fermentative production of vitamins and antibiotics has been curtailed in favor of increased work on fermentative production of microbial insecticide products.

Successful development of a continuous batter process for wet-milling wheat flour into starch and gluten, now being evaluated by industry, has afforded a concentrated effort on the dry milling and air-classification of cereal grains to produce fractions with good chemical and economic potential for indutrial uses.

An integrated wool processing pilot plant has been put into operation in order to intensify processing research and to make practical evaluation of new laboratory developments in the improvement of wool textiles.

In fiscal year 1959 a total of 131 projects were terminated for the following reasons:

Research objectives attained	66
Research objectives partially attained	37
Research results unpromising	5
Superseded by research of higher priority	7
Exploratory research to define specific phases of a problem	16
TOTAL	131

New phases of work in broad areas of research and the initiation of research in entirely new areas are undertaken on the various commodities to the extent funds become available from discontinued researches or from new funds. Increasing emphasis is being placed on industrial utilization where opportunities exist for advantageously broadening the consumption of the various farm commodities in such uses, and on fundamental and exploratory research essential to effective advances in the applied field. Of the 132 new research projects initiated during F.Y. 1959, 79 were to develop new industrial uses for agricultural products. Distribution of these 132 new projects is as follows:

	Industrial Uses	Food & Feed Uses	Total
Cereal grains and forages	22	13	35
Cotton and wool	28	-	28
Fruits and vegetables	-	22	22
Oilseeds	13	5	18
New and special crops	12	2	14
Poultry, dairy, animal products	4	11	15
TOTAL	79	53	132

IV. CURRENT RESEARCH PROGRAM (F. Y. 1960)

Utilization research in the Agricultural Research Service is conducted in four Utilization Research and Development Divisions. Facilities consist of four large regional laboratories and ten smaller field laboratories. The number of scientific and technical personnel employed in the four Divisions is approximately 850.

The current program consists of:

329 projects in the utilization laboratories supported by regular appropriations (exclusive of projects under domestic contracts)

77 projects under domestic contracts

4 projects in the laboratories supported by funds supplied by transfer from other Federal agencies

20 projects supported by industry (fellowships)

17 projects in foreign countries under Public Law 480.

The principal areas of research are:

Cereal Grains and Forages

Primary emphasis is on wheat and corn, with lesser attention to other small grains such as rice, barley, sorghum, and oats; alfalfa and other forage products are under investigation.

New Industrial uses for chemically modified high-amylose starch, dialdehyde starch, and wheat flour.

Fermentative and chemical procedures for producing new industrial materials.

Improved procedures for conditioning, grinding, and air classification of wheat and corn, and for wet-milling of high-amylose corn.

Development of processes for increasing the feeding value and efficiency of grains and forages.

Ways to maintain "fresh" quality in bakery and newly developed cereal food products through freezing and other methods.

Cotton and Wool

Investigations include chemical, physical and mechanical processing research and supporting fundamental studies of fiber properties and their modifications.

New chemical treatments for cotton and wool to give fabrics and other products better adapted to specific end-uses.

New types of mechanical processing equipment to improve the quality of cotton products and the efficiency of producing them.

Improved fabric constructions to meet specific requirements for clothing, household, and industrial uses.

Fruits and Vegetables

Research aimed to develop fruit and vegetable products that are attractive, economical, nutritive and meet the increasing demand for convenience-in-use, and to develop processes and equipment for manufacture of these products.

New processes for concentrating, drying, freezing, dehydrofreezing, and dehydrocanning of fruits and vegetables.

Time-temperature tolerance studies of frozen fruit and vegetable products as a basis for process and product improvement.

Compositional and enzyme studies as requisites to development of new and improved processed fruit and vegetable products having greater color stability, better flavor, and enhanced textural properties.

Oilseeds

Major consideration given to soybean, cottonseed, and linseed oils and related products, with lesser efforts on castor, tung and other oilseeds. Research stresses new and broadened industrial uses, and includes substantial effort to improve feed and food uses.

New chemical products derived from vegetable oils and new industrial uses developed for these materials.

Improved methods for extraction and processing to achieve broadened industrial, food and feed uses for oilseeds.

Fundamental studies on composition and properties of vegetable oils as required for developing industrial products of economic utility and food products of higher quality.

New and Special Crops

Investigations directed toward the development of compositional data which will lead to improved processing techniques and products of enhanced value.

Improved techniques for the processing of sugarcane, sugar beet and maple sap, and new uses for honey.

Development of new industrial chemicals from naval stores.

Screening of large numbers of plant materials for alternate crops, with special emphasis on sources of new types of oils for industrial uses that are not competitive with domestic vegetable oils and animal fats.

Research on the chemical composition of tobacco and tobacco smoke in relation to quality of tobacco.

Poultry, Dairy and Animal Products

Research directed to discover new industrial uses and outlets for animal fats and hides, and to develop new food products of high quality, convenience, and consumer appeal, from milk, poultry, eggs, and the more economical cuts of meat.

New uses for animal fats in plastics, detergents, and lubricants.

New tanning processes which yield leathers with improved properties to afford broader usages, especially in the garment field.

Development of an "instant" dry whole milk powder with prolonged fresh flavor quality.

Ways to retain flavor, increase stability, and create greater tenderness in meat and poultry products.

New processes for achieving greater variety of egg products with increased flavor acceptance and stability.

V. PROGRAM FOR UTILIZATION RESEARCH

To increase present uses for farm products on a scale that will materially alleviate the most serious of our agricultural surpluses and expand or create new markets for a wide variety of our farm crops requires an integrated and intensive program of applied research.

Farm utilization research should be expanded in the following areas:

Cereals and Forages

1. Development of new and improved industrial products, such as plastics, lubricants, detergents, sizing agents, surface coatings, adhesives, antibiotics and insecticides from wheat and corn.

2. Improvement in the quality and stability of baked products, and in the efficiency of the processes for making them, to maintain and expand this major market for wheat.

3. Development of means for improving and retaining the feed value of cereals and forage crops.

4. Basic research on the composition of cereals and forages, and on the chemical and physical changes that the constituents of these crops undergo, to provide the clues for developing better, more stable foods and feeds and in developing raw materials of wider variety and appeal to industrial users.

Cotton and Wool

1. Development of treatments that confer upon cotton and wool new or improved qualities such as wrinkle, heat, rot, weather and flame resistance for cotton; wrinkle, yellowing, shrink and insect resistance for wool.

2. Development of improved textile equipment and processing techniques to produce cotton and wool products of better quality and greater versatility at lower costs.

3. Continuing study of the price-quality relationships of cotton, wool and their modified forms, and of competitive products to guide research and development along lines that hold greatest promise for expanding markets for these textile fibers.

4. Fundamental research on the physical and chemical properties of cotton and wool fibers as a basis for developing practical means for enhancing their good qualities and for overcoming their deficiencies.

Fruits and Vegetables

1. Development of low cost, high quality, processed products that are convenient to keep and prepare for serving and that do not require expensive refrigeration or packaging.

2. Improvement of equipment and processing methods for freezing, dehydro-freezing, dehydrating, canning and irradiation of fruits and vegetables to maintain high quality and to reduce processing costs.

3. Basic studies of the composition and properties of fruit and vegetable constituents necessary to guide applied research for improvement of nutritive value, texture, color, flavor, and stability of processed products.

Oilseeds

1. Development of new and improved industrial products, such as plasticizers, paints, detergents, lubricants, coatings and adhesives from the oils of soybeans, flaxseed, cottonseed, tung nuts, and castor beans.

2. Improvement of the stability of the vegetable oils used as food, and modification of their chemical and physical properties useful in the development of salad and cooking oils, shortenings and spreads, to meet changing consumer demands.

3. Improvement in the feed qualities of cottonseed, soybean and other oilseed meals, by development of processes to eliminate toxic factors and to enhance nutritive value.

4. Development of practical means for removing technological obstacles to the expanded export of U. S. oilseeds.

5. Basic research on the composition of oilseeds, and on the chemical and physical changes that the constituents of these crops undergo, vital to the development of new and better food, feed and industrial products.

New and Special Crops

1. Development of economically sound products from potential new crops that will make them profitable alternates for those now grown in surplus.

2. Fundamental research on the identification of the constituents of tobacco and tobacco smoke, and the changes in composition that occur during curing, fermenting, and aging, as a necessary requisite to industry's providing products having the qualities preferred by consumers.

3. Development of new and enhanced industrial chemicals from pine gum and its components, gum rosin and turpentine, useful in the manufacture of such materials as paints, coatings, plastics, rubber, and detergents.

4. Improvement in the efficiency of processing sugar cane and sugar beets to reduce costs, and creation of new industrial chemicals from sugar.

Animal Products

1. Detailed studies of the components of milk and on their interactions during processing, necessary to the production and storage of diversified, higher quality processed milk products.

2. Development of new and improved industrial products -- such as plastics, plasticizers, lubricants, detergents, and coatings -- from animal fats.

3. Development of processed convenient-to-use products from meat, poultry, dairy and eggs that possess and retain the flavor, texture, nutritive, and functional properties characteristic of high quality fresh products.

4. Development of quicker, more efficient tanning processes for converting hides to leathers of unique properties, and at prices that will create new and expand existing markets.

VI. FISCAL INFORMATION

The 1959 and 1960 Utilization Research and Development Research budgets and the proposed budget for fiscal year 1961 are as follows:

	1959	1960 (estimated)	Increase	1961 (estimated)
Cereal and forage crops	3,047,307	3,092,600	+1,200,000	4,292,600
Cotton, wool and other fibers.....	3,314,262	3,289,600	+600,000	3,889,600
Fruits and vegetables	2,558,943	2,628,800	- -	2,628,800
Oilseeds	1,903,363	1,957,300	+100,000	2,057,300
New and special plants	1,660,781	1,614,700	- -	1,614,700
Poultry, dairy, and animal products.....	3,302,219	3,533,700	+300,000	3,833,700
Total	15,786,875	16,116,700 a/	+2,200,000 b/	18,316,700 c/

The proposed increase would be applied as follows:

Research to increase the industrial use of cereal grains	1,200,000
Research to develop new and improved textiles and processes — cotton $500,000; wool $100,000	600,000
Research on castor oil to develop materials for use in solid fuels and other products and to improve the utilization of castor meal	100,000
Research to expand or find new uses for animal fats	300,000
Increase, utilization research development	2,200,000

a/ Does not include $4,300 from special fund for employment of additional labor.
b/ Does not include $12,800 estimated for health benefit costs.
c/ Does not include $113,100 estimated for health benefit costs for base funds.

Physical facilities at the Utilization Research Laboratories are efficiently used by approximately 1600 scientists and supporting workers. The budget increase proposed for 1961 provides for 120 additional scientists. Some further increase in staff is possible within existing facilities as resources permit. Substantial expansion of utilization research would require additional facilities that could be added at present sites, provision for increasing the present program of cooperative utilization research with the State Agricultural Experiment Stations, and contract research with these and other public and private research organizations.